GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Fundamentals of modern physics, PG_00049441					
Field of study	Technical Physics					
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028	
Education level	first-cycle studies		Subject group		Obligatory subject group in the field of study Subject group related to scientific research in the field of study	
Mode of study	Full-time studies		Mode of delivery		at the university	
Year of study	2		Language of instruction		Polish	
Semester of study	4		ECTS credits		5.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Division of Physics of Organic and Perovskite Photovoltaic Structures -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology					
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Ireneusz Linert				
	Teachers					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM	
	Number of study hours	60	5.0	60.0	125	
Subject objectives	The student knows and understands fundamentals of moder physics.					

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W02] possesses structured knowledge of the fundamentals of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and molecular physics, solid-state physics, and nuclear and particle physics.	The student knows the basics of modern physics, which developed at the turn of the 19th and 20th centuries, the experiments carried out and the concepts of the structure of the atom that led to the creation of quantum and atomic physics, starting from the Stefan-Boltzmann law and Planck's theory of radiation emission, through the discovery of the electron, the atomic nucleus, the de Broglie hypothesis, the Davisson-Germer experiment, the photoelectric effect, the Compton effect, the Heisenberg uncertainty principle, the Bohr model of the atom and the theory of atomic spectra, the basics of quantum mechanics, the production of X-ray radiation, the creation of electron-positron pairs, and the theory of relativity.	[SW1] Assessment of factual knowledge
	[K6_U01] demonstrates the ability for lifelong independent learning, including acquiring information from literature, databases and other appropriate sources.	Based on the knowledge gained in the subject, the student is able to independently develop and deepen his/her knowledge in the field of modern physics based on literature and source materials.	[SU3] Assessment of ability to use knowledge gained from the subject
	[K6_U02] is able to analyse and solve complex and non-standard scientific and technical problems using appropriate analytical, computational, numerical, simulation or experimental methods.	Students learn to solve tasks/ problems in contemporary physics using advanced mathematical tools. This allows them to acquire the skills to solve new, complex, and unusual problems.	[SU3] Assessment of ability to use knowledge gained from the subject
	[K6_W01] demonstrates an understanding of the civilisational significance of physics and its applications.	The student has knowledge of the importance of modern physics for the development of civilization and modern technology.	[SW1] Assessment of factual knowledge

Subject contents

Course content – lecture

Atomic Structure of Matter Statistical Physics. Boltzmann Factor. Maxwell's Distribution. The Atom, Atomic Size, Determination of Atomic Parameters from the Kinetic Theory of Gases, Rutherford's Experiment. Emission and Absorption of Radiation. Blackbody, Spontaneous Emission, Stimulated Absorption and Emission, Blackbody Emission, Planck's Distribution, Stefan-Boltzmann Law, Wien's Displacement Law. Theory of Relativity: Michelson-Morley Experiment. Einstein's Postulates. Lorentz Transformations. Time Dilation and Length Contraction. Twin Paradox. Relativistic Momentum and Energy. General Relativity. Fundamental Properties of Matter: De Broglie's Hypothesis, Davisson-Germer's Experiment, Photoelectric Effect, Compton Effect, Heisenberg's Uncertainty Principle, Fermi-Dirac, Bose-Einstein, and Boltzmann Distributions. Bohr's Model of the Hydrogen Atom. Bohr's model and theory of the atom, Bohr's postulates, energy levels of the hydrogen atom, photon absorption and emission, ionization, hydrogen-like atoms, muon atoms. Quantum mechanics. Postulates of quantum mechanics, the wave function, energy and momentum operators, the Schrödinger equation, atomic magnetic moments, electron spin, total angular momentum, fine and hyperfine structure. Multi-electron atoms. Quantum numbers, the Pauli exclusion principle, the Zeeman effect. Atomic spectra. Spectra formation, types of spectra, X-ray radiation.

Course content – exercises

Course Content - Exercises

During the calculus exercises, students solve calculus problems illustrating selected topics discussed in lectures. The problems cover topics such as the fundamentals of statistical physics (the Boltzmann factor, Maxwell's distribution, determining atomic parameters based on the kinetic theory of gases, the barometric formula, transport phenomena in gases), thermal radiation (blackbody emission, Planck's distribution, Stefan-Boltzmann's law, Wien's displacement law), the fundamentals of quantum mechanics (the Bohr model of the atom and its applications), the fundamental properties of matter (the photoelectric effect, the Compton effect), and elements of relativity theory (relativistic momentum and energy, the conversion of mass into energy, and binding energy).

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
	0.0%	15.0%
Tests during the semester	50.0%	45.0%
Written exam	50.0%	40.0%

<table>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. P. A. Tripler, R. A. LLewellyn, Fizyka Współczesna, PWN, Warszawa 2011.
2. R. Eisberg, R. Resnick, Fizyka kwantowa atomów, cząsteczek, ciał stałych, jąder i cząsteczek elementarnych, PWN, W-wa 1983
3. H. A. Enge, M.R. Wehr, J. A. Richards, Wstęp do fizykiatomowej, PWN, W-wa 1983
4. H. H. Haken, H. C. Wolf, Atomy i kwanty, PWN, W-wa 1997
5. V. Acosta, C. L. Cowan, B. J. Graham, Podstawy fizyki współczesnej, PWN, W-wa 1987
6. Halliday, Resnick, Walker, Podstawy Fizyki PWN, W-wa 2014.</td></tr>
<tr><td>Supplementary literature</td><td>1. A. A. Czerwiński, Energia jądrowa i promieniotwórczość, Oficyna edukacyjna, W-wa 1998
2. Sz. Szczeniowski, Fizyka doświadczalna, tom V (fizyka atomu); tom VI (fizyka jądra i cząstek elementarnych), PWN, W-wa 1974
3. K.Wróblewski, J. A. Zakrzewski, Wstęp do fizyki, t. 1, Wydawnictwo Naukowe PWN, Warszawa 1984.
4. J. Massalski, Fizyka dla inżynierów. Część II. Fizyka współczesna, WNT, Warszawa 2018.
5. E. Skrzypczak, Z. Szafliński, Wstęp do fizyki jądra atomowego i cząstek elementarnych, PWN, W-wa 2002
6. H. H. Haken, H. C. Wolf, Atomy i kwanty, PWN, W-wa 1997
7. Matwiejew, Fizyka cząsteczkowa, W-wa 1989, PWN.</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/
example questions/
tasks being completed</td><td colspan="2">The problems for tutorials:

1. Using the energy distribution of molecules in an ideal gas, derive formulas for the energy corresponding to the mean energy of gas molecule. Calculate the value for the ideal gas in room temperature T=300 K. 2. What is the frequency of the photon absorbed when the hydrogen atom makes the transition from the ground state (n=1) to the n=4 state?

The exam questions:

Draw and explain the Maxwell-Boltzmann speed distribution function. Show in the graph the shape of that function for a given temperature and present how the graph is changing when the gas temperature increases. Present the method of determining the specific e/m of electron in the Thomson experiment.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="2">Not applicable</td></tr>
</table>

Document generated electronically. Does not require a seal or signature.